FOOD HABITS OF THE BARRED DOVE IN HAWAII

BY CHARLES W. SCHWARTZ AND ELIZABETH REEDER SCHWARTZ[1]

OF THE nearly one hundred avian species introduced into the Hawaiian Islands since their discovery by the English explorer Cook in 1778, few have become established. Even fewer have increased as prolifically as has the Barred Dove (*Geopelia s. striata*), a native of Malaya. The successful establishment and increase of this species is doubtless related to its ability to breed the year around in the equable coastal climate (Schwartz and Schwartz, 1950) and to feed upon a wide variety of plant foods.

The Barred Dove probably was first introduced into Hawaii in 1922 when a shipment of doves from Australia was liberated on the islands of Oahu, Kauai, Maui, Lanai, and probably Molokai (Caum, 1933; Munro, 1944; D. Fleming, in conversation). The original planting on Lanai did not succeed. The bird became established there some time after 1929, reaching the island unaided, probably from 10-mile distant Maui (Munro, 1944). Barred Doves have been seen flying to and from Kauai and Niihau and volunteer flight between these islands, a distance of 18 miles, is responsible for establishment of the species on Niihau where it is very abundant (L. Robinson, in conversation; Fisher, 1951). The Barred Dove's occurrence on the island of Hawaii dates from approximately 1935, but whether or not it arrived with human assistance is not known. On this island the bird inhabits only the leeward coast, at the closest point 29 miles distant from Maui, but its range and population here are still increasing.

The Barred Dove now inhabits all the major islands, ranging from sea-level to 4000 feet elevation (the highest elevation in the group being 13,784 feet). The total area occupied is approximately 1475 square miles. Throughout this habitat the mean annual temperature ranges from 75°F. at sea-level to 60°F. at 4000 feet, with a monthly fluctuation in mean of less than 8°F. Rainfall varies from about 10 to 160 inches annually. The bird inhabits nearly all types of land including urban and homestead areas, pineapple and sugar cane plantations, truck gardens, pasture lands, and waste areas exclusive of barren lava.

[1] This study was made from February, 1946, through July, 1947, in connection with a survey of game birds in the Hawaiian Islands, Project 1-R of the Federal Aid–Wildlife Program of the Board of Commissioners of Agriculture and Forestry of the Territory of Hawaii (Schwartz and Schwartz, 1949). We are grateful to E. Y. Hosaka of the University of Hawaii Agricultural Experiment Station and B. P. Bishop Museum, G. O. Fagerlund, formerly with the Hawaii National Park, and H. St. John of the University of Hawaii, for identification of certain plants; and to Ernst Mayr, of the American Museum of Natural History, for subspecific identification of the dove specimens collected.

Adult Barred Dove (*Geopelia striata*). Photographed at Lihue on Kauai of the Hawaiian Group, in October, 1946, by Charles and Elizabeth Schwartz.

It seldom uses the heavily-forested sections in which the rainfall is extremely high (up to 450 inches annually), visiting only the margins where clearing and road maintenance support and encourage desirable food plants.

The bird is most abundant from sea-level to about 2000 feet elevation along the coast. Throughout this favored habitat the mean annual temperature is between 75° and 70°F., and rainfall between 10 and 40 inches annually. Densities up to 800 birds per square mile, even higher in certain localities, exist where there is a combination of attractive roosting cover, water, and an abundance of food of the xerophilous type. Roosting cover is furnished by dense algaroba (*Prosopis chilensis*) and koa haole (*Leucaena glauca*). Water is available in seeps and cattle watering-troughs. Temperatures lower than 60°F. and rainfall higher than 160 inches annually probably limit distribution. Where temperatures are lower the preferred food plants do not flourish, and where rainfall is heavier the eggs or young may be adversely affected or the cover becomes so dense as to be unattractive for nesting.

Early in the morning, shortly after the doves leave their roosting places, they start feeding casually in the vicinity. They may spend considerable time dusting and sunning and males may indulge in courtship displays and songs.

The birds usually feed in pairs or family groups—i.e., two adults and two recently fledged young. Although hundreds of birds may gather at common feeding, watering, or idling places, they do not form definite flocks or age-groups. Our collecting failed to indicate any segregation of the sexes.

Where food and water are available near roosting places, no extensive daily flights are necessary; but where attractive feeding areas (e.g., the pineapple fields on Lanai) are far removed from the roosting places, flights up to three and even five miles may be taken late in the morning. The daily period of greatest feeding activity is in the afternoon (Figure 1). Ninety birds taken after 3 p.m. had well filled crops (average crop content: 3.4 cc.; one very full crop contained 15.0 cc.). Wherever a considerable flight to a good feeding ground is necessary, there is an evening flight also—back to the roosting place.

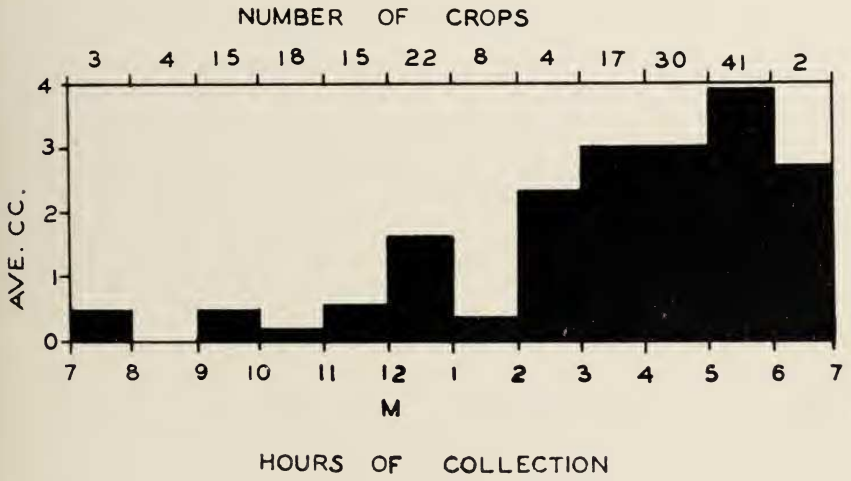

Fig. 1. Variation in volume throughout the day in Barred Dove crop contents.

In the Hawaiian Islands the Barred Dove and another introduced species, the Lace-necked Dove (*Streptopelia c. chinensis*), often feed in the same fields, but they usually do so during different stages of cultivation or plant succession. In general, the Barred Dove feeds on small seeds, while the Lace-necked Dove takes larger seeds and fruits. There is no competition between them for food. Only three plants were shown by our studies to be present in the alimentary tracts of the two dove species in quantities of more than one percent by volume, and these plants, *Waltheria americana*, *Lantana Camara*, and *Sida* sp., are plentiful throughout the ranges of both birds (Schwartz and Schwartz, 1951).

Since the Barred Dove subsists mainly on foods providing little moisture, surface water is a necessity. We have observed the doves drinking at rainwater puddles, cattle watering troughs, brackish and fresh-water pools or seeps, irrigation ditches, and reservoirs.

TABLE 1

FOODS OF THE BARRED DOVE IN HAWAII

Species	Percent of crop volume	Number of occurrences in 165 crops	Number of occurrences in 136 gizzards
Plants (seeds unless otherwise indicated)	96.7		
Amaranthus hybridus, spleen amaranth	15.9	57	48
Setaria verticillata, bristly foxtail	11.7	56	33
Paspalum Urvillei, vasey grass	9.7	10	8
Portulaca cyanosperma, small pigweed; seed, pod	8.9	33	15
Waltheria americana, uhaloa	7.4	42	58
Eleusine indica, wire grass	7.0	19	2
Lantana Camara, Lantana; seed, fruit	5.4	6	12
Setaria geniculata, yellow foxtail	3.4	13	6
Echinochloa colonum, jungle rice grass	3.3	4	6
Digitaria horizontalis, kukaipuaa	2.6	9	8
Sida rhombifolia, ilima	2.6	8	5
Setaria glauca, yellow foxtail	2.2	3	3
Sida sp., ilima	1.9	14	6
Richardia brasiliensis, Richardsonia	1.8	5	3
Atriplex semibaccata, Australian salt bush	1.5	13	5
Euphorbia hypericifolia, graceful spurge	1.5	8	6
Unidentified seeds and debris	1.2	13	2
Sida cordifolia, ilima*			
Sida fallax, ilima*	1.1	6	8
Digitaria sanguinalis, large crab grass	1.1	5	2
Portulaca oleracea, pigweed	0.9	25	8
Euphorbia hirta, garden spurge	0.7	27	9
Cynodon Dactylon, Bermuda grass	0.6	13	10
Emilia sonchifolia, red pualele	0.6	12	0
Panicum maximum, guinea grass	0.6	7	2
Cuphea carthagenensis, tarweed	0.5	1	1
Hordeum vulgare, barley	0.5	1	0
Siegesbeckia orientalis, small yellow crown beard	0.5	10	2
Tephrosia purpurea, ahuhu	0.5	9	11
Amaranthus spinosus, spiny amaranth	0.2	9	2
Carica papaya, papaya	0.2	1	0
Casuarina sp., ironwood	0.2	6	4
Scirpus sp.	0.2	2	2
Chenopodium sp.	0.1	2	2
Grevillea robusta, silk oak	0.1	1	0
Solanum nodiflorum, popolo	0.1	5	2
Abutilon molle, mao	T	3	5
Ananas comosus, pineapple; root	T	1	0
Bidens pilosa, pilipili	T	2	0
Centaurea melitensis, Maltese thistle	T	3	0
Chloris inflata, swollen finger grass	T	3	0

TABLE 1—*Continued*

Species	Percent of crop volume	Number of occurrences in 165 crops	Number of occurrences in 136 gizzards
Plants (continued)			
Dodonaea viscosa, aalii	T	4	17
Echinochloa crusgalli var. *crus-pavonis*, barnyard grass	T	5	0
Eclipta prostrata	T	1	1
Heliotropium curassavicum, hinahina	T	1	1
Lepidium auriculatum, pepper plant	T	1	1
Malva parviflora, little mallow	T	3	2
Malvastrum coromandelianum, false mallow	T	2	5
Momordica Balsamina, balsam apple	T	1	0
Nicandra Physalodes, apple of Peru	T	1	0
Oryza sativa, rice	T	1	0
Oxalis corniculata, sweet sour, sorrel	T	1	0
Paspalum conjugatum, Hilo grass	T	1	1
Passiflora sp.	T	2	2
Phaseolus lathyroides, wild pea bean	T	3	0
Polygonum sp.	T	1	1
Prosopis chilensis, algaroba, kiawe; seed, leaf, pod	T	1	1
Sporobolus indicus	T	3	0
Tricholaena repens, Natal redtop	T	3	1
Verbena litoralis, Verbena	T	7	6
Animals	*3.3*		
Carpophilus humeralis, yellow-shouldered souring beetle; adult	2.7	5	4
Muscoidea, fly; larva	0.4	1	0
Carpophilus hemipterus, dried fruit beetle; adult	0.2	6	3
Bruchus amicus, bean weevil; adult	T	1	0
Bruchus prosopis, bean weevil; adult	T	1	0
Coleoptera, beetle; larva	T	1	0
Conoderus exsul, wireworm; larva	T	3	0
Insecta (unidentified), insect; pupa	T	1	0
Megacerus alternatus, pea weevil; adult	T	1	1
Oxidus gracilis, thousand-legged worm; adult	T	1	0
Vespoidea, wasp; adult	T	1	0

* The seeds of these species are practically indistinguishable, hence they are combined herein.

The Barred Dove's food in Hawaii is 96.7 percent vegetable and 3.3 percent animal. Fifty-nine species of plants and 11 species of animals are represented (Table 1). The vegetable matter is almost wholly small seeds from rapidly-maturing herbaceous annuals and grasses which thrive under disturbed soil conditions. Most of these grow in open fields or along roadsides and are soon

replaced by the heavier growth of later annuals or cultivated species. Climatic conditions influence the distribution both of these preferred foods and of the doves themselves.

The following detailed report on the Barred Dove's food is based upon an analysis of the contents of 165 crops (and gizzards of 136 of the same birds) as well as upon extensive field observations. We carried out all field work, analyses, and computations ourselves. The contents of crops were dried, identified, separated, and measured in cubic centimeters; frequency of occurrence was recorded; and the aggregate volume was ascertained. Gizzard contents were identified and recorded for occurrence only. We discuss the foods on an annual basis because no great seasonal difference occurs in the food supply of doves in Hawaii, although there may be periods, especially following rains in the drier regions, when certain plant species produce seeds more abundantly. Specimens for this study were collected on all the major islands occupied by the species except Niihau, and from all months of the year except July.

The eight most important foods on the basis of volume and frequency of occurrence in crops (more than 6 percent or more than 15 occurrences) we wish to discuss in particular. Other foods, while occurring in small amounts and few crops, are doubtless valuable as they contribute to variety in the diet and furnish essential nutrients. Only small amounts of fruit (*Lantana Camara*), root (*Ananas comosus*), seed pods (*Portulaca cyanosperma* and *Prosopis chilensis*), and leaves (*P. chilensis*) are eaten. Animal foods are relatively unimportant: almost the entire measurable volume consists of two species of *Carpophilus* beetles. When old pineapple fields are plowed under, these beetles, which commonly infest pineapple, are exposed and the doves gather in large numbers to feed upon them. None of the insects eaten by the dove are known to be hosts of internal helminth parasites common to other game birds in Hawaii. This probably explains the absence of such parasites in the dove specimens we examined.

Important Barred Dove Foods

Amaranthus hybridus, spleen amaranth, is the most common food. The seeds of this exotic species, a native of tropical America, formed 15 percent of the diet and were present in 57 (34 percent) crops and 48 (35 percent) gizzards. The plant grows commonly in the margins of cultivated areas, in fallow fields, and along roadsides below 2500 feet elevation, producing an abundance of seed all year.

Setaria verticillata, bristly foxtail, an exotic grass from Europe and Asia, formed 11 percent of the food. Its seeds were present in 56 (33 percent) crops and 33 (24 percent) gizzards. It grows commonly below 2500 feet elevation and is important because of its widespread distribution. It produces seed the year around (to a lesser extent in winter). The birds usually strip the seed-heads in feeding. Where this grass grows in abundance the doves may gorge themselves exclusively on its seeds during given feeding periods.

Paspalum Urvillei, vasey grass, an exotic from South America, formed 9 percent by volume of the dove's food. Seeds were present in 10 (6 percent) crops and 8 (5 percent) gizzards.

Although the plant grows up to 4000 feet elevation, it is abundant only locally in pastures and along roadways and trails. Here the doves feed heavily upon it. The seed crop is produced mostly during spring, summer, and fall. Along forest roadways the marginal growth of this grass is largely responsible for the dove's presence. The bird lingers in such forested areas only as long as seeds are produced.

Portulaca cyanosperma, an endemic small pigweed, formed 8 percent of the dove's food. We found it in 33 (20 percent) crops and 15 (11 percent) gizzards. The plant is common only below 200 feet elevation on the island of Kauai but since its seeds were eaten by a large percentage of birds collected there, its importance cannot be overlooked. It is frequently associated with algaroba (*Prosopis chilensis*) and provides a ready source of food for birds using these trees for roosting and nesting. It produces seed all year but chiefly during fall, winter, and spring. Both the seeds and pods are eaten, the tiny seeds being ingested with the pods.

Waltheria americana, an exotic from tropical America, constituted 7 percent of the dove's food. Its seeds were found in 42 (25 percent) crops and 58 (42 percent) gizzards. Commonly known as uhaloa, this species of the Sterculiaceae is widespread up to 4000 feet elevation and has an abundant seed production throughout the year.

Eleusine indica, or wire grass, an exotic from the tropics of the Old World, grows below 2500 feet elevation in shallower, poorer soils. Its distribution is spotty, and the doves concentrate upon it when it is in seed. Its seeds, which formed 7 percent of the Barred Dove's diet, were present in 19 (11 percent) of the crops and 2 (1 percent) of the gizzards examined. The low incidence of occurrence in gizzards is probably more apparent than real. We did not even open the gizzards of many doves whose crops were filled with wire grass seeds.

Portulaca oleracea, an exotic pigweed from Europe, formed less than one percent of the total food, but because we found it in 25 (15 percent) crops and 8 (5 percent) gizzards, we consider it an important food. The seeds are extremely small and thousands of them must be consumed before they become an appreciable item. The plant grows commonly below 2500 feet elevation in disturbed soil, especially in young sugar cane and pineapple plantations and other cultivated areas.

Euphorbia hirta, or garden spurge, is an exotic from tropical America. Its tiny seeds contributed less than one percent to the total food volume but were present in large numbers in 27 (16 percent) crops and 9 (6 percent) gizzards. It abounds in Barred Dove range up to 2500 feet elevation along roadsides and in fields in early stages of cultivation. It produces seeds the year around, but its value to the doves varies with the stage of cultivation of the different plantations.

Grit recovered from crops and gizzards consisted of rounded or angular pieces of olivine, basalt, quartz, dried earth, feldspar, coral, and glass. The pieces ranged from 0.5 to 4.0 mm. in diameter, those between one and two mm. in diameter being most common. Only 12 crops contained grit (average grit content: 0.2 cc.). Of the 136 gizzards examined, 60 contained grit (average grit content: 0.2 cc.), 60 contained only a trace, and 16 were without grit.

In the Philippine Islands the Barred Dove eats some rice. Manuel (1934) obtained the "stomachs" of 305 Luzon birds, finding the contents to be 70 percent weed-seed and 30 percent rice. In Luzon the dove's food habits are considered of neutral importance since the bird eats rice from the stubble after the harvest. Rice is not grown extensively in the Hawaiian Islands and no depredations by Barred Doves in the rice fields were reported to us, though complaints against the rice bird (*Munia punctulata topela*) were frequent and numerous. While the parts and types of plants used as food by *Geopelia striata* are similar in these widely separated island-groups, only two species—*Paspalum conjugatum* and *Portulaca oleracea*—were found in the alimentary tracts of *both* Hawaiian and Philippine doves examined.

Only one bird of the 305 examined in connection with the Philippine study had eaten any

animal matter. This individual had eaten 170 dipterous pupae. In our Hawaiian study we recorded a low percentage of dipterous larvae, and animal matter in general formed a very small part of the total food.

Summary

The food of the Barred Dove in the Hawaiian Islands is almost wholly vegetable. Analysis of the *food* contents of 165 crops and 136 gizzards (from the same birds): 96.7 percent plant matter (principally small seeds); 3.3 percent animal matter (almost wholly beetles of the genus *Carpophilus*). Seeds most commonly eaten are from rapidly maturing herbaceous annuals and grasses which thrive in disturbed soil. Some grit is ingested—average amount in 12 crops and 60 gizzards: 0.2 cc.

The dove feeds most actively in the afternoon. Birds may feed and roost in the same locality if conditions are suitable, but where good feeding areas are far removed from favored roosting places daily flights of from three to five miles may be taken. Since the dove obtains little moisture from its food it must drink: surface water is therefore an important range-requirement.

Literature Cited

Caum, Edward L.
1933 The exotic birds of Hawaii. B. P. Bishop Mus. Occ. Papers, 10 (9): 1–55.
Fisher, Harvey I.
1951 The avifauna of Niihau Island, Hawaiian Archipelago. *Condor*, 53: 31–42.
Manuel, Canuto G.
1934 Food and feeding habits of the Barred Ground Dove. *Philippine Jour. Sci.*, 55: 69–77.
Munro, George C.
1944 Birds of Hawaii. Tongg Publ. Co., Honolulu.
Schwartz, Charles W., and Elizabeth Reeder Schwartz
1949 The game birds in Hawaii. Bd. Comm. Agr. and For., Honolulu.
1950 Breeding habits of the Barred Dove in Hawaii with notes on weights and sex ratios. *Condor*, 52: 241–246.
1951 A survey of the Lace-necked Dove in Hawaii. *Pacific Science*, 5 (1): 90–107.

Conservation Commission, Jefferson City, Missouri